Are Postoperative Clinical Outcomes Influenced by Length of Stay in the Postanesthesia Care Unit?

Jamie Mann-Farrar, RN, BN, MHSM, Elizabeth Egan, RN, BN, Andrew Higgins, RN, BN, Leigh Wysocki, RN, BN, Amanda Vaux, RN, BN, MNP (Crit. Care), Elise Arndell, RN, BN, Elizabeth A. Burmeister, RN, BN, MSc, PhD

Purpose: *To compare clinical outcomes of patients who required a prolonged length of stay in the postanesthesia care unit (PACU) with a control group.*
Design: *A single-center purposive-sampled retrospective medical record and database audit.*
Methods: *Patients with prolonged PACU stays were compared to a group of patients whose stay was less than median for outcome measures: rapid response team (RRT) activation, cardiac arrest, unanticipated intensive care unit admissions, and survival to discharge.*
Findings: *A total of 1,867 patients were included in the analysis (*n *= 931 prolonged stay and* n *= 933 control group). Prolonged stay in PACU was higher among patients who were older, had higher American Society of Anesthesiologist score, and were discharged to wards during the afternoon or late nursing shift. RRT activation after discharge from PACU occurred in more patients in the study group compared with the control group (7% vs 1%, respectively). There were no cardiac arrests recorded in either group within the 24 hours after PACU discharge period.*
Conclusions: *Prolonged stay in the PACU for 2 or more hours because of clinical reasons appears to be associated with a higher incidence of clinical deterioration in the ward setting requiring RRT intervention within 24 hours after discharge from PACU.*

Keywords: *postoperative deterioration, rapid response, PACU, postanesthesia care unit, surgical deterioration, rapid response team.*

SINCE INCEPTION IN 1940s, the predominant setting for patient recovery immediately after surgery in Australia has been the postanesthesia care unit (PACU), also historically referred to as the recovery room.[1] Nursing staff in these units, typically registered nurses (RNs), use a highly specialized skill set and comprehensive nursing assessment to recognize and respond to

Jamie Mann-Farrar, RN, BN, MHSM, Princess Alexandra Hospital, Brisbane, Australia, and School of Nursing and Midwifery, University of Tasmania, Tasmania, Australia; Elizabeth Egan, RN, BN, Post Anesthetic Care Unit, Princess Alexandra Hospital, Brisbane, Australia; Andrew Higgins, RN, BN, Post Anesthetic Care Unit, Princess Alexandra Hospital, Brisbane, Australia; Leigh Wysocki, RN, BN, Post Anesthetic Care Unit, Princess Alexandra Hospital, Brisbane, Australia; Amanda Vaux, RN, BN, MNP (Crit. Care), Emergency Department, Princess Alexandra Hospital, Brisbane, Australia; Elise Arndell, RN, BN, Post Anesthetic Care Unit, Princess Alexandra Hospital, Brisbane, Australia; and Elizabeth A. Burmeister, RN, BN, MSc, PhD, Nursing Practice Development Unit, Princess Alexandra Hospital, Brisbane, Australia.

Conflict of interest: None to report.

Address correspondence to Jamie Mann-Farrar, Princess Alexandria Hospital, 199 Ipswich Road, Woolloongabba QLD Australia; e-mail address: jamie@anaes-assist.com.au.

1089-9472/$36.00
https://doi.org/10.1016/j.jopan.2018.07.004

complications from anesthesia, surgery, or coexisting diseases.[2,3] As patients recover from anesthesia and throughout the transition to ward readiness, PACU nurses maintain continuous monitoring. PACU staff have a strong interprofessional relationship with surgical staff and anesthesia providers. This facilitates access to advanced clinical and pharmacologic interventions that are used to treat well-known clinical risks in early postoperative care, including hypoxemia, aspiration, hemorrhage, hypotension/hypertension, thermoregulation distortions, uncontrolled pain, nausea and vomiting, fluctuations in sedation and consciousness,[2,3] thus, counteracting patient clinical deterioration while in the PACU.

In concluding the episode of PACU care, RNs determine the suitability of the patient for discharge from PACU and return to a ward setting using a variety of assessments tools.[4-6] A recent systematic review identified that only one randomized controlled trial examining patient readiness-for-discharge assessment by RNs, in PACU, had been published in the last 40 years.[4]

Historically, predicting and preventing postoperative deterioration after discharge from PACU has not been a focal point of inpatient deterioration research, despite the broad appeal of such work. In the absence of other easily available quality outcome measures, postoperative mortality has been used as a surrogate marker of postoperative deterioration.[7-10] Until recently, other important indicators of clinical deterioration such as the incidence of rapid response team (RRT) activation, unplanned intensive care unit (ICU) admission, and cardiac arrest rates after discharge from PACU were unknown.

Emerging in the last 12 months, two studies have initiated discourse on predicting and preventing deterioration after discharge from PACU.[11,12] One of the studies considered the effect of a newly developed observation, response, and discharge chart by comparing preimplementation and postimplementation outcomes.[11] The study was conducted in three Australian hospitals and compared the rate of clinical deterioration, cardiac events, and other adverse events. They reported the rate of adverse events after discharge from PACU remained constant (16.5%), but the rate of cardiac events (5.1% vs 2.6%; $P = .021$) and clinical deterioration (8.7% vs 4.3%; $P = .001$) after PACU discharge significantly decreased after implementation of the new chart.

In the second study, the investigators aimed to record the incidence of early postoperative deterioration and identify factors predictive of at-risk patients. After binomial logistical regression analysis of 747 patient clinical records, they identified that postoperative deterioration was common with PACU deterioration occurring in 20.1% of patients ($n = 155$) and on ward deterioration occurring in 16.7% of patients ($n = 125$). Common ward events included hypotension (64; 8.2%) and desaturation (59; 6.2%). They observed that an RRT call occurred for 33 (4.4%) patients and an unplanned ICU admission for seven (0.9%) patients. The study identified that a history of atrial fibrillation and chronic liver disease, duration of surgery and excessive sedation in PACU, among others, were strongly associated with subsequent ward deterioration. However, measures of surgical complexity were not.[12]

These recent developments highlight that PACU discharge decisions and decision-making tools may be useful predictors of future ward deterioration, although work in this regard is limited.

Purpose

The primary purpose of this research was to evaluate if a longer stay in PACU owing to ongoing treatment was associated with patient clinical outcomes after discharge to the ward. A secondary purpose of the research was to describe the clinical factors associated with a prolonged stay in PACU.

Methods

This single-center purposive-sampled retrospective medical record audit was conducted at the Princess Alexandra Hospital, Brisbane, Australia. Approval was obtained from the hospital Human Research Ethics Committee on June 21, 2016 (HREC/16/QPAH/355). Permission was also obtained from the data custodian, the office of the Director-General, Queensland Health.

Setting

The study was undertaken at the Princess Alexandra Hospital, an adult tertiary hospital in Brisbane, Australia. The hospital has approximately 750 inpatients at any time with an annual approximate turnover of 104,300 patients and 21,600 operating theater cases performed including 1,600 transplant service separations, in all adult specialties except obstetrics and burns.

Participants

Patients were included in the study if they underwent an elective procedure that required an inpatient admission between January 2014 and June 2015 and were discharged from PACU to inpatient wards. They were excluded from the study if:

1. They had a prolonged stay in PACU for nonclinical reasons, including bed management or organizational factors.
2. They had electroconvulsive therapy or elective cardioversions in the operating room (OR) as a booked procedure.
3. They were younger than 18 years.
4. They were day-only admissions.
5. They died while in the OR or PACU.
6. They had a planned direct transfer from OR to the ICU.

The time from admittance to PACU until they were ready for discharge to the ward was used to calculate length of stay for all patients.

Patients were included in the study group if they had a prolonged length of stay in PACU for clinical causes. Clinical causes were defined as patients requiring active intervention for a condition at or beyond a 2-hour time frame and included hypotension or hypertension requiring intravenous treatment; persistent hypoxemia requiring oxygen therapy; unresolved pain; persistent nausea and vomiting; anemia requiring blood transfusion and unexplained neurologic changes (such as confusion, delirium, seizures, drowsiness).

A comparison group was randomly selected from patients whose time in PACU was less than the median time of stay of all patients in PACU of 35 minutes (control group).

The medical record audit was undertaken using the OR management software, ORMIS (Computer Sciences Corporation, Falls Church, VA) to obtain the study population, patient demographic data, and patient and clinical details of time in PACU until ready for discharge to the ward. Other sources of data included the hospital rapid response database, inpatient case-mix and statistics database for crude mortality, and Metavision ICU (IMDsoft, Tel Aviv, Israel) for unanticipated ICU admissions data.

OUTCOMES. The main outcome event was patient clinical deterioration with a surrogate outcome measured by RRT calls. Other outcomes included cardiac arrests, unexpected ICU admissions, and survival to discharge during the study period and were reported for each patient included in the study.

The Princess Alexandra Hospital operates a two-tier response system for deteriorating patients, the first being ICU nurse-led outreach service and the second being an RRT. Table 1 provides criteria used to activate the RRT at the facility.

Cardiac arrest was defined as a medical event requiring cardiopulmonary resuscitation or defibrillation or would have required these interventions had the decision not been made at the scene to withhold resuscitation. Only cardiac arrests where the RRT were called to attend were included in the analysis. Information on arrests managed by local staff, without the attendance of the RRT, was not recorded in hospital databases.

Unplanned ICU admissions were defined as unscheduled admissions from any inpatient wards and included coronary care unit and direct admissions from PACU.

EXPLANATORY VARIABLES. Patient characteristics including age, sex, and the American Society of Anesthesiologist (ASA) score for comorbidities before surgery were reported (Table 2).

Other variables recorded included the day of the week that the surgery was performed; the type of surgery categorized into orthopaedic, vascular, neurosurgical, general, and other; and the

Table 1. Clinical Criteria for Activating an RRT

Respiratory
• Rate < 8 or >36 breaths per min
• Pulse oximeter reading less than 90%
Heart rate
• < 40 or >140 beats per min
Blood pressure
• < 90 mm Hg
Neurologic
• Acute changes to consciousness
• Signs & symptoms of a stroke
Other
• Chest pain
• Staff concern

RRT, rapid response team.

department (surgery or other) the patients were discharged to from PACU.

In the study group, details of treatment received in PACU for systolic blood pressure of less than 90 mm Hg or greater than 160 mm Hg; chest pain (self reported); persistent hypoxia (pulse oximetry < 90%); nausea and vomiting; anemia requiring blood transfusion; unexplained neurologic changes; or other clinical concerns requiring medical review (unquantified nursing concern) were also collected.

Table 2. Patient Demographics by Study Group

Characteristic	Study Group (n = 931)	Control Group (n = 933)	P*
	N (%)†		
Age (y)			< .001
Younger than 40	166 (18)	244 (26)	
40-59	257 (28)	285 (31)	
60-69	165 (18)	179 (19)	
70 and older	343 (37)	225 (24)	
Sex			< .001
Men	567 (61)	643 (69)	
Women	364 (39)	290 (31)	
ASA			< .001
< III	296 (32)	460 (49)	
III or III E	502 (54)	402 (43)	
>III	133 (14)	71 (8)	

ASA, American Society of Anesthesiologists.

*P values calculated using Mann-Whitney test for continuous variables and χ^2 test for categorical data.

†N = number of patients.

Data Analysis

All data were analyzed using Stata, version 14.2 (StataCorp, College Station, TX), and a P value of < .05 was considered an indication of statistical significance.

Descriptive statistics were reported, and differences between study and control groups were analyzed using χ^2 test and Fisher exact test for categorical data and as data were not normally distributed, Mann-Whitney tests for continuous data.

The associations between all explanatory variables and RRT call were examined using logistic regression, and the crude odds ratios (ORs) were estimated. Variables significant at the 0.10 level were included forward stepwise in a multivariable logistic regression model, and adjusted odds ratios (AORs) were estimated.

Finding

Of a total of 1,864 patients, 931 were included in the study group and 933 in the control group. There were more men in the control group than the study group (69% & 61%, respectively) (P < .001). More than half (55%) of the patients in the study group were older than 60 years, and 86% of the patients (798 of 931) had an ASA of less than III; III; or IIIE (Table 2).

More patients had a prolonged length of stay for clinical reasons during the weekdays than weekends and during the late shift, with 70% of all occurring between 3 p.m. and 11 p.m. (P < .001). The three main reasons for prolonged clinical stay were unresolved pain, hypotension, and clinical concern accounting for 32% (299 of 931), 20% (186 of 931), and 25% (231 of 931) of all occurrences, respectively (Table 3). Together, these constituted 83% (716 of 931) of the prolonged stay for clinical reasons.

RRT activation within 24 hours after discharge from PACU occurred in 69 (7%) patients in the study group compared with 12 (1%) patients in the control group (P < .001) (Table 4). Patients in the study group were significantly more likely

Table 3. Clinical Reasons for PACU Stay for More Than 2 hours

Reason	*N* (%)
Unresolved pain	299 (32)
Other clinical concern*	231 (25)
Hypotension	186 (20)
Hypoxia	71 (8)
Hypertension	59 (6)
Anemia requiring blood transfusion	43 (5)
Unexplained neurologic changes	25 (3)
Chest pain	6 (1)
Nausea and vomiting	11 (1)

PACU, postanesthesia care unit.

*Other clinical concerns include a worrying appearance, an alarming behavior, or a clinical condition that remains within acceptable parameters, yet has worrying features.

to have an RRT call on their return to the ward than those in the control group after adjusting for the patients age, ASA category, and the department they were discharged to (AOR, 5.64; 95% confidence interval, 2.98 to 10.69) (Table 4). Patients older than 70 years compared with those younger than 40 years were significantly more likely to have an RRT (AOR, 8.83; 95% confidence interval, 2.61 to 29.97). Patients with ASA class more than three compared with those with ASA of less than three were more likely to have an RRT call, but after adjusting for age, study group, and discharge destination, this was not statistically significant.

Orthopaedic surgery was associated with 37% of prolonged stay patients in PACU and together with general surgery accounted for more than half (58%) of the prolonged stay in PACU episodes.

There were no cardiac arrests recorded in either the study group or the control group within the 24 hours after PACU discharge period. Fourteen patients in the study group required an unanticipated ICU admission, whereas no patient in the control group required the same ($P < .001$). With respect to hospital mortality and survival to discharge, statistical significance between groups could not be demonstrated. Although not statistically significant, a small difference was noted in survival to discharge with 22 (2%) patients in the study group compared with 11 (1%) patients in the control group not surviving to discharge ($P = .053$).

Discussion

Hospital systems that are designed to recognize and rapidly respond to clinical deterioration are not new. Evidence of the impact of response systems on the safety and survival of hospitalized patients is contradictory. Investigators in some studies report improvements in cardiac arrest rates, unplanned admissions to ICU, and hospital mortality rates, and yet other comparable studies report no difference.[13] In their systematic review, Smith et al[14] noted that more than 11,000 studies have been undertaken that have considered clinical deterioration in hospitalized patients, yet only eight studies addressed the prospect of predicting deterioration. Recently, attention has turned to the predictive value of PACU discharge assessments and decision making, and it has been suggested that PACU is an optimal environment to assess the likelihood of future deterioration.

At the Princess Alexandra Hospital, the PACU is the only unit where patients are cared for with continuous monitoring and the bedside presence of nurses specialized in the identification of early postoperative complications. The investigators of this study speculated that patients requiring a prolonged stay in this environment, to stabilize their clinical condition, were potentially signaling that the patient's physiology was on a deterioration trajectory. The investigators suspected that the trajectory was temporarily halted by the care provided in PACU and that once the patient left the unit the deterioration trajectory would possibly resume.

This study suggests that patients who remain in PACU for more than 2 hours, because of clinical reasons after surgery, are more likely to encounter clinical deterioration after return to wards than patients who have a routine stay in PACU. This study also found that the incidence of prolonged length of stay in PACU for clinical causes was greater during the week than on weekends, which is believed to reflect that complex elective surgery at this institution is performed during the week. Finally, this study suggests that prolonged stay in PACU was higher among patients who were older, had high ASA, and were discharged to wards during the afternoon/late nursing shift and could be of interest to further investigations.

Table 4. Incidence of RRT

		RRT Intervention		
Occurrence	**Total**	***N* (%)**	**OR (95% CI)**	**AOR* (95% CI)**
Time in PACU				
2 h or more (study group)	931	69 (7)	1.00	1.00
< 35 min (control group)	933	12 (1)	6.14 (3.30-11.42)	5.64 (2.98-10.69)
Day of week admitted to PACU				
Sunday	152	2 (1)	1.00	1.00
Monday	298	12 (4)	3.15 (0.70-14.24)	2.19 (0.47-10.16)
Tuesday	312	20 (6)	5.14 (1.18-22.27)	3.46 (0.78-15.32)
Wednesday	304	18 (6)	4.72 (1.08-20.62)	2.70 (0.60-12.10)
Thursday	303	12 (4)	3.09 (0.68-14.00)	1.87 (0.40-8.67)
Friday	324	8 (2)	1.90 (0.40-9.05)	1.38 (0.28-6.71)
Saturday	171	9 (5)	4.17 (0.89-19.60)	4.88 (1.00-23.70)
Department discharged to from PACU				
Other†	369	24 (7)	1.00	1.00
Surgery	1,495	57 (4)	1.75 (1.07-2.87)	2.18 (1.27-3.71)
Shift returned to ward				
Early (7 a.m.-3 p.m.)	676	22 (3)	1.00	1.00
Late (3 p.m.-11 p.m.)	1,094	58 (5)	1.66 (1.01-2.75)	1.05 (0.62-1.77)
Night (11 p.m.-7 a.m.)	94	1 (1)	0.32 (0.04-2.40)	0.20 (0.03-1.51)
Type of surgery‡				
Orthopaedic	344	29 (8)	1.00	1.00
Vascular	123	3 (2)	0.27 (0.08-0.91)	0.20 (0.06-0.68)
Neurosurgical	84	4 (5)	0.54 (0.19-1.59)	0.65 (0.21-1.99)
General	191	14 (7)	0.86 (0.44-1.67)	1.04 (0.52-2.07)
Other	189	19 (10)	1.21 (0.66-2.23)	1.25 (0.65-2.40)
Treatment in PACU				
Control group/no treatment	933	12 (1)	1.00	1.00
Hypotension	186	34 (18)	17.17 (8.70-33.89)	12.55 (6.19-25.46)
Chest pain, hypoxemia, nausea and vomiting, anemia requiring blood transfusion, and neurologic changes	156	14 (9)	7.57 (3.43-16.69)	6.42 (2.84-14.50)
Unresolved pain	299	11 (4)	2.93 (1.28-6.71)	3.32 (1.43-7.73)
Other clinical concern§	290	10 (3)	2.74 (1.17-6.41)	2.66 (1.12-6.32)

RRT, rapid response team; OR, odds ratio; 95% CI, 95% confidence interval; AOR, adjusted odds ratio; PACU, postanesthesia care unit.

*Adjusted for American Society of Anesthesiologist, age, long or short stay, and department discharged to from PACU.

†Other department includes medical, oncology, and rehabilitation wards.

‡Type of surgery only known for long-stay patients.

§Other clinical concerns include a worrying appearance, an alarming behavior, or a clinical condition that remains within acceptable parameters, yet has worrying features.

Implications for Practice

This study has identified that there is significant predictive value in determining deterioration for patients that remain under active treatment in PACU for clinical reasons for more than 2 hours. An awareness of this may begin to alter clinical practice in particular to the location and level of care provided to the at-risk prolonged stay patients. Future practice might include a longer stay in PACU to ensure patient safety; an ICU outreach consultation for patients with a prolonged stay in PACU or initiating dialog with patient flow administrators to determine an appropriate level-of-care ward after discharge from PACU. Transferring the necessary information

through communication and handover is an important part of the discharge process from PACU to the ward for all patients, but we suggest that a prolonged stay in PACU should be noted with the team leader of nursing staff on the ward with respect to altering nurse-to-patient ratios and should form a component of handover to receiving ward nurses.

Limitations

Although robust outcome measures that had been used in previous studies were used in this study, these outcomes may have been influenced by other factors unable to be controlled for by our study design. This study research was conducted in a single center, was retrospective, and did not collect data on individual patient management, patient illness severity, or experience of staff. It was possible neither to determine if surgical cases were classified as emergency cases arising from clinical need or for bed management requirements nor to adjust for specific surgical procedures or patient comorbidities. The study was also unable to determine the rate of RRT criteria breaches that occurred and were not acted on for patients discharged to the ward from PACU.

Suggestions for future research would be to identify and quantify the predictors of a patient's long stay in PACU. Sensitivity analyses to determine the length of stay in PACU, which best predicts clinical deterioration after discharge to the ward, would enrich the evidence base in this field. A nomogram could also be developed to enable PACU staff to determine a discharge clinical risk assessment score for individual patients, which could be useful for both hospital administrators and clinicians.

Conclusion

This study has demonstrated that a prolonged stay in the PACU for 2 or more hours because of clinical reasons is associated with a higher incidence of future deterioration on the ward. This group of patients is significantly more likely to require RRT intervention than those that stay in PACU for less than a median length of stay (less than 35 minutes). A prolonged stay in PACU for clinical reasons also increases the risk of unanticipated ICU admission within the next 24 hours of return to ward. There might also be a correlation in decreased survival to discharge in these patients; however, further research is required in this area.

Acknowledgments

The authors thank Rod Hurford, Intensive Care Unit Princess Alexandra Hospital, Brisbane, for assistance with data sourcing and Mark Bennett, Data Analyst, Perioperative Services, Princess Alexandra Hospital. This study was made possible by the Division of Surgery, Princess Alexandra Hospital.

References

1. Smith BA, O'Brien D. The post anesthesia care unit. In: Drain CB, Odom-Forren J, eds. *Drain's Perianaesthesia Nursing: A Critical Care Approach*, 6th ed. St. Louis, MO: Saunders; 2013:1-8.

2. Truong L, Moran JL. Post anaesthesia care unit discharge: A clinical scoring system versus traditional time-based criteria. *Anaesth Intensive Care*. 2004;32:33-42.

3. O'Brien D. Postanesthesia care complications. In: Drain CB, Odom-Forren J, eds. *Perianaesthesia Nursing: A Critical Care Approach*, 6th ed. St. Louis, MO: Saunders; 2013: 394-414.

4. Phillips NM, Street M, Kent B, et al. Post-anaesthetic discharge scoring criteria: Key findings from a systematic review. *Int J Evid Based Healthc*. 2013;11:275-284.

5. Riley R, Brotto V, Alexander L. Developing a post-anaesthetic discharge scoring system: Methodological and clinical issues. *Aust Soc Post Anaesth Anaesth Nurses Newsl*. 2006; 10:6-14.

6. Ead H. From Aldrete to PADSS: Reviewing discharge criteria after ambulatory surgery. *J Perianesth Nurs*. 2006;21: 259-267.

7. Heeney A, Hand F, Bates J, et al. Surgical mortality—An analysis of all deaths within a general surgical department. *Surgeon*. 2014;12:121-128.

8. Ayoade BA, Thanni LO, Shonoiki-Oladipupo O. Mortality pattern in surgical wards of a university teaching hospital in southwest Nigeria: A review. *World J Surg*. 2013;37: 504-509.

9. Sileshi B, Newton MW, Kiptanui J, et al. Monitoring anesthesia care delivery and perioperative mortality in Kenya utilizing a provider-driven novel data collection tool. *Anesthesiology*. 2017;127:250-271.

10. Story DA, Leslie K, Myles PS, et al. Complications and mortality in older surgical patients in Australia and New Zealand (the REASON study): A multicentre, prospective, observational study. *Anaesthesia*. 2010;65:1022-1030.

11. Petersen Tym M, Ludbrook G, Flabouris A, et al. Developing models to predict early postoperative patient deterioration and adverse events. *ANZ J Surg*. 2017;87:457-461.

12. Street M, Phillips N, Mohebbi M, et al. Effect of a newly designed observation, response and discharge chart in the Post Anaesthesia Care Unit on patient outcomes: A quasi-experimental study in Australia. *BMJ Open*. 2017;7:e015149.

13. Mitchell A, Schatz M, Francis H. Designing a critical care nurse-led rapid response team using only available resources: 6 Years later. *Crit Care Nurse*. 2014;34:41-54.

14. Smith M, Chiovaro JC, O'Neil M, et al. Early warning system scores for clinical deterioration in hospitalized patients: A systematic review. *Ann Am Thorac Soc*. 2014;11:1454-1465.